

Claims

[1] A residual stress improving apparatus for piping, arranged to irradiate an outer peripheral surface of piping having a straight pipe portion with laser light, comprising:

 a laser head portion holding one laser head or a plurality of the laser heads for delivering the laser light; and

 circumferential direction moving means for moving the laser head, together with the laser head portion, along the outer peripheral surface of the straight pipe portion, and along a circumferential direction about a pipe axis of the straight pipe portion.

[2] The residual stress improving apparatus for piping according to claim 1, characterized in that

 an orientation of the laser head is adjusted in a plane intersecting the pipe axis of the piping, whereby a direction of delivery of the laser light is adjusted in the plane so that the laser light reflected by the outer peripheral surface of the piping does not return to the laser head.

[3] The residual stress improving apparatus for piping according to claim 1, further comprising reflection direction adjusting means for

adjusting an orientation of the laser head in a plane intersecting the pipe axis of the piping to adjust a direction of delivery of the laser light in the plane, thereby adjusting a direction of reflection of the laser light so that the laser light reflected by the outer peripheral surface of the piping does not return to the laser head.

[4] The residual stress improving apparatus for piping according to any one of claims 1 to 3, characterized in that

the piping has the straight pipe portion, and a bending pipe portion continued from the straight pipe portion, and

an orientation of the laser head is adjusted in a plane including the pipe axis of the piping, whereby a direction of delivery of the laser light is adjusted in the plane so that an outer peripheral surface of the bending pipe portion located forwardly, in a direction of the pipe axis, of the laser head is irradiated with the laser light.

[5] The residual stress improving apparatus for piping according to any one of claims 1 to 3, characterized in that

the piping has the straight pipe portion, and a bending pipe portion continued from the straight pipe

portion, and

the residual stress improving apparatus for piping further comprises delivery direction adjusting means for adjusting an orientation of the laser head in a plane including the pipe axis of the piping, thereby adjusting a direction of delivery of the laser light in the plane so that an outer peripheral surface of the bending pipe portion located forwardly, in a direction of the pipe axis, of the laser head is irradiated with the laser light.

[6] The residual stress improving apparatus for piping according to claim 4 or 5, further comprising:

pipe axis direction moving means for moving the laser head portion along the pipe axis direction, thereby making it possible to adjust a position of irradiation with the laser light on the outer peripheral surface of the bending pipe portion.

[7] The residual stress improving apparatus for piping according to any one of claims 4 to 6, further comprising:

oscillating means for moving the laser head in an oscillatory manner along the pipe axis direction; and

output adjusting means for adjusting an output of the laser light so that the laser light delivered

from the laser head at each oscillation position of the laser head has a uniform irradiation intensity on the outer peripheral surface of the bending pipe portion.

[8] The residual stress improving apparatus for piping according to any one of claims 4 to 6, characterized in that

a plurality of the laser heads are arranged along the pipe axis direction, and

the residual stress improving apparatus for piping further comprises output adjusting means for adjusting an output of the laser light so that the laser light delivered from each of the plural laser heads has a uniform irradiation intensity on the outer peripheral surface of the bending pipe portion.

[9] The residual stress improving apparatus for piping according to any one of claims 1 to 3, characterized in that

the piping has the straight pipe portion, and a bending pipe portion continued from the straight pipe portion, and

the residual stress improving apparatus for piping further comprises pivoting means for pivoting the laser head portion about a pivot center in a plane including the pipe axis, the pivot center being a pivot

shaft located on a rearward side, in a direction of the pipe axis, of the laser head portion, thereby making it possible to bring a forward side, in the pipe axis direction, of the laser head portion close to and away from an outer peripheral surface of the bending pipe portion.

[10] The residual stress improving apparatus for piping according to claim 9, further comprising:

pipe axis direction moving means for moving the laser head portion along the pipe axis direction, thereby making it possible to adjust a position of irradiation with the laser light on the outer peripheral surface of the bending pipe portion.